DOCUMENT RESUME

ED 446 501 HE 033 311

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TITLE	Changes in the Demand for Public Land-Grant Universities in New England, 1976-1999. AIR 2000 Annual Forum Paper.
PUB DATE	2000-00-00
NOTE	47p.; Paper presented at the Annual Forum of the Association for Institutional Research (40th, Cincinnati, OH, May 21-24, 2000).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC02 Plus Postage.
DESCRIPTORS	Academic Aspiration; College Applicants; College Bound Students; *College Choice; Family Income; Higher Education; *Land Grant Universities; Out of State Students; Public Colleges; Scores; Tuition
IDENTIFIERS	New England; Scholastic Assessment Tests; University of New Hampshire

ABSTRACT

This study focuses on initial student interest in or demand for public, land-grant universities (PLGUs) within the six New England states for the years 1976-99. The study has three distinguishing features. First, time-series data for the six New England states are combined into a panel data set, and fixed effects and random effects models are used to estimate how selected factors affect the demand for PLGUs in the region. Second, this study utilizes data on the proportion of seniors in each state who had their test scores sent to particular PLGUs within the region as a measure of demand. Finally, student demand models are estimated for (1) demand for their own in-state PLGU and (2) demand for the University of New Hampshire among non-New Hampshire seniors in New England. The results for New England show that the changing pattern in the demand for PLGUs from 1976 through the late 1990s has been largely due to: changes in the relative price of attending public and competing institutions; changes in median family income; and the rising degree aspirations of college-bound seniors. (Contains 41 references.) (SM)

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Changes in the Demand for Public Land-Grant Universities in New England, 1976 - 1999

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Changes in the Demand for Public Land-Grant Universities

in New England, 1976 - 1999

Abstract

This study focuses on initial student interest or demand for public, land-grant universities ("PLGU's") within the six New England states for the years 1976 through 1999. There are three distinguishing features of this study. First, time-series data for the six New England states are combined into a panel dataset, and fixed effects and random effects models are used to estimate how selected factors affect the demand for PLGUs in the region. Second, this study utilizes data on the proportion of seniors in each state who had their test scores sent to particular PLGUs within the region as a measure of demand. Finally, student demand models are estimated for (1) demand for their own in-state PLGU, and (2) demand for the University of New Hampshire among non-New Hampshire seniors in New England. The results for New England show that the changing pattern in the demand for PLGUs from 1976 through the late 1990s has been largely due to changes in the relative price of attending public and competing institutions, changes in median family income, and the rising degree aspirations of college-bound seniors.

Changes in the Demand for Public Land-Grant Universities

in New England, 1976 - 1999

Introduction

Public institutions are an important feature of the American higher education system. They perform a variety of functions within their respective states, including imparting knowledge on citizens, and training students for important professions within each state such as education and medicine. The passage of the Morrill Act of 1862 led to the establishment of public land grant universities, which in addition to the traditional roles of public institutions also became involved in conducting research and fulfilling other state needs in areas such as agriculture.

Today, public higher education in the United States faces a number of serious challenges. As relative financial support from state governments has dwindled, many public institutions are experiencing significant revenue constraints and find themselves concerned about maintaining sufficient enrollment levels to meet operating expenses. The frequent use of tuition discounting in the private sector has made them more competitive with the public sector. As performance indicators such as the average SAT scores of incoming freshmen become increasingly used to rate and reward colleges, institutions face pressure to not only enroll students in sufficient numbers, but also attract better students. Finally, legislators and citizens have charged the public sector with the responsibility for ensuring that traditionally disadvantaged students, such as those from lower income families and/or families without college-educated parents, have appropriate access to a postsecondary education.

These challenges highlight the need within the public sector to better understand issues surrounding the enrollment decisions of students. This need has risen in the 1990s as

postsecondary enrollments nationwide grew at a much slower pace than in the preceding decade, and the private sector grew at a faster pace than the public sector. As can be seen in Table 1, these two trends have been especially pronounced in New England, where the public sector has traditionally faced significant competition for students from private colleges and universities. The first section of the table shows for all public institutions in new England their total fall enrollments for three selected years by state. The second portion of the table contains similar information for all New England private institutions by state, and the last three rows of the table provide comparable figures for all public and private institutions in the United States:

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Insert Table 1 Here

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The divergence in demand for public and private institutions is a nationwide phenomenon, with public enrollments rising by 2.3% between 1990 and 1996 as compared to an almost 8% growth rate for private institutions for the same period. In New England, public and private institutions had similar growth rates from 1975 through 1990, but in the ensuing years the private sector grew by 1.3% while public enrollments in the region declined by almost 7%.

There are two other notable features of public higher education in New England. First, the tuition and fees charged by public institutions in the region to out-of-state students are two to three times as high as the rates they charge to in-state students, and both in-state and out-of-state rates are among the highest in the nation. Second, a number of these institutions enroll a significant number of out-of-state students, and rely quite heavily on their tuition revenue as a source of meeting operating expenses in light of falling state support. Accordingly, public

institutions have a need to understand how particular factors influence not only student demand within their state, but also in the neighboring states from which they draw many non-resident students.

Many studies have been conducted by researchers on various aspects of student demand for higher education. These studies have utilized either cross-sectional data on the decisions made by individual students, or time-series data on the aggregate numbers of students making particular postsecondary choices. Among the key findings from these studies are that student demand is relatively insensitive to changes in the price of attendance, and that students tend to prefer institutions where their ability matches the average abilities of students.

The literature on student demand for higher education has helped inform policymakers, but the various approaches used by analysts have empirical limitations. While the majority of student demand studies focus on enrollment behavior, this can present problems for analysts since enrollment figures can be influenced by the supply of spaces made available by the institution, as well as the demand for those spaces among college-bound students. In time-series studies of student demand the sample sizes are typically small, which leads to larger standard errors in the statistical models estimated from the data. For this reason, analysts often turn to cross-sectional data to study student demand, but in the process lose the ability to draw direct conclusions about the sensitivity of student demand to changes in the price of attendance.

This study focuses on initial student interest or demand for public, land-grant universities (referred to here as "PLGUs") within the six New England states for the years 1976 through 1999. There are three major distinguishing features of this study. First, time-series data for the six New England states are combined into a panel dataset, and fixed effects and random effects

models are used to estimate how selected factors affect the demand for PLGUs in the region. Second, rather than focusing on enrollment behavior, this study utilizes data on the proportion of seniors in each state who have taken the SAT and had their test scores sent to particular PLGUs within the region as a measure of demand. Given that the New England PLGUs require applicants to submit SAT scores for admission consideration, the act of having test scores sent to an institution is a good indicator of initial student demand. Likewise, as noted by Kodrzycki (1999), the act of taking the SAT is a good indicator of a student's interest in attending college. This formulation also has the benefit of avoiding the supply constraint problem that could possibly affect enrollment figures. Finally, two types of student demand models will be estimated for New England states: (1) student demand for their own in-state PLGU, and (2) student demand for the University of New Hampshire among non-New Hampshire seniors who have taken the SAT. The second model is useful for illustrating how the factors affecting a student's initial decision to go to an out-of-state PLGU compare to those identified for in-state PLGUs.

Literature Review

Dating back to the work of Ostheimer (1953), Campbell and Siegel (1967) and others, there has been a large volume of literature written on the topic of student demand for higher education. Reviews of the literature include Jackson and Weathersby (1975), Radner and Miller (1975), Becker (1990), and Paulsen (1990). Empirical studies can be categorized according to the level at which the data are aggregated. Paulsen (1990) refers to these categories as micro-level and macro-level studies. Micro-level studies utilize cross-sectional data in an attempt to

explain the postsecondary choices of individual students. Examples of micro-level studies include Ehrenberg and Sherman (1982), Venti and Wise (1983), Carter and Savoca (1984), Rouse (1994), Weiler (1994), and DesJardins, Dundar, and Hendel (1999). Micro-level studies are appealing in that they can utilize larger datasets, but due to the cross-sectional nature of the data they cannot directly infer the price sensitivity of student demand.

Macro-level studies use time-series data to focus attention on the behavior of groups of students rather than individual students. The dependent variable in these studies is typically the number or proportion of individuals in a designated population each year who demand a particular institution or group of institutions. Examples of macro-level studies include Campbell and Siegel (1967), Spies (1973), Lehr and Newton (1978), Doyle and Cicarelli (1980), Shim (1990), Parker and Summers (1993), Hsing and Chang (1996), and Wetzel, O'Toole and Peterson (1998). Hoenack and Weiler (1979) note that most macro-level studies during the 1970s were conducted for groups of institutions. Macro-level studies have an advantage over micro-level studies in that they can estimate the price sensitivity of students, but they usually have relatively few degrees of freedom with which to estimate the parameters and standard errors in the model. A hybrid approach recently used in several studies of student demand (e.g., Toutkoushian and Hollis, 1998; Wetzel, O'Toole & Peterson, 1998; Heller, 1999) involves the pooling of macro-level data across a series of years into a single dataset. Such a dataset is referred to as a panel dataset, and special statistical methods known as fixed effects and random effects models have been developed to estimate the parameters of interest in the model.

Some analysts have concentrated specifically on student demand for public colleges and universities. Hoenack and Weiler (1979), Rives and Cassidy (1982), Seneca and Taussig (1987),

DesJardins et al. (1998), and others have estimated demand models for single public institutions. For sets of public institutions, Hoenack (1967; 1971) investigated how income and several other factors influenced the proportions of graduates from California high schools who attended one of the campuses of the University of California. Doyle and Cicarelli (1980) examined student demand for a set of forty public four-year institutions, using the ratio of resident freshman enrollments to high school graduates as their dependent variable. Dickey, Asher, and Tweddale (1989) focused on changes over time in the proportions of residents in Michigan from various age categories who enrolled in one of the public institutions in the state. As part of their study of state funding for public higher education, Toutkoushian and Hollis (1998) estimated a demand model for the number of students in each state enrolling in public institutions from 1990 to 1996. Finally, Heller (1999) investigated state-level changes in all fifty states in the ratio of public enrollments to the 18- to 24-year old populations for the years 1976 to 1994.

Whether a micro-level or macro-level approach is used, studies can also differ with respect to the specific measure of student demand that could be used. The majority of studies published to date have used enrollments to represent student demand, and then attempt to explain how factors such as tuition, income, and academic ability affect the enrollment behavior of students. While the interest in enrollments seems natural, Spies (1973), Becker (1990), Savoca (1990), and Parker and Summers (1993) argue that this is not a precise measure of student demand since enrollment figures will also be affected by the number of spaces made available by the institution.[1] Such concerns are smaller when the institution in question has an open admissions policy, or the analysis concentrates on broad groupings of institutions, but enrollments are still conditional on applying and being admitted to the institution in question.

An additional concern for many student demand studies is that the samples often include individuals who have no intention of going to college. The student decision-making process can be viewed as a four-stage nested process: (1) whether to consider a postsecondary education, (2) whether to consider a particular set of institutions, (3) whether to apply to particular institutions, and (4) whether to enroll in one of the institutions to which the student is admitted.[2] If demand is defined as the share of all high school graduates or 18- to 24-year olds in a state who enroll in an institution, it is not clear whether the effects of selected regressors on the proportion enrolling are explaining a student's decision to enroll, apply, or initially consider a postsecondary education. This formulation presumes that everyone in the designated population is willing and able to attend the college(s) in question. The same concern applies to micro-level studies when the sample includes individuals who do not go to college. Among the exceptions are Parker and Summers (1993), who examine the share of admitted students who enroll in selected institutions, and DesJardins et al. (1999), where the sample consists of students within a five-state region who have taken the ACT.

As a result of these concerns, a number of analysts have turned their attention to understanding the early stages of student demand, such as why students apply to or initially consider attending particular institutions. Chapman (1979), Venti and Wise (1982), Paulsen (1990), Savoca (1990), Weiler (1994), and DesJardins et al. (1999), for example, explain why students apply to a given institution. By focusing on why students apply to certain institutions, the identification problem can be minimized.[3] These and other studies have shown that price and income effects can explain student application behavior as well as student enrollment behavior. Finally, studies by Tierney (1983) and Toutkoushian (2000) have analyzed an even earlier stage

of student demand, as represented by whether a student had his or her SAT score sent to a particular institution, and show that many of the same relationships found for enrollment and application behavior apply to SAT-sending behavior.

Several findings have emerged from the research of student demand on public higher education.[4] First and foremost is that there is a negative but weak relationship between demand and the price of attendance (e.g., Hoenack, 1967, 1971; Doyle & Cicarelli, 1980; Rives & Cassidy, 1982; Wetzel et al. 1998). Heller (1999), for example, concluded that a $1,000 increase in public tuition rates led to only a one-half of one percent decline in the share of 18- to 24-year-olds in a state enrolling in their in-state public institutions. There is some debate as to whether list or net tuition rates are the appropriate measure of "price" to use in student demand models. An argument can be made that the list price is a better price measure for studies of initial student demand. While Hubbell (1992) notes that less than sixty percent of students pay the listed tuition rate at their institution, he goes on to say that "...the increasingly artificial stated rate is the price that is conveyed to prospective students." Kodrzycki (1999) agrees with this opinion, noting that since the list price is more visible than net price to prospective students, it may have the largest impact on early stages of student demand. Since most students submit their SAT scores to institutions in their junior year or the fall of their senior year and do so prior to applying for admission, they may have little information on the specific tuition discount they may be offered at different institutions. At the same time, students may have formed expectations of the level of tuition discounting at different institutions, and used this information when deciding where to have their test scores sent.

The effects of tuition changes at competing institutions on demand are more ambiguous,

in part due to the relatively small sample sizes commonly found in time-series studies and the fact that tuition rates across institutions are often highly correlated (Hoenack and Weiler, 1979; Becker, 1990). Nonetheless, Seneca and Taussig (1987) found that student demand for Rutgers University increased as the cost of attending institutions that compete with Rutgers increased. Tierney (1980) concluded that the demand for private institutions fell as the ratio of private to public tuition rates rose. Toutkoushian and Hollis (1998) showed that a one percent increase in average private tuition and fees led to a 0.2 percent increase in public institution enrollments. In contrast, Heller (1999) found little evidence that increases in community college tuition rates led to an increase in demand for four-year public institutions, and vice-versa.

While the majority of studies have shown that increases in income lead to increases in the demand for postsecondary education (e.g., Spies, 1973; Venti & Wise, 1983; Becker, 1990, Rouse, 1994; McPherson & Shapiro, 1998), the evidence for the public sector alone is mixed. Doyle and Cicarelli (1980), Zemsky, Shaman, and Berberich (1980), Seneca and Taussig (1987), and DesJardins et al. (1999) showed that increases in income led to a decline in demand for particular public institutions. In contrast, Hoenack (1967) found positive income elasticities for California public institutions, and Dickey, Asher, and Tweddale (1989) found that the enrollment rates of women in public institutions in Michigan rose with income.[5] Finally, Toutkoushian and Hollis (1998) found no relationship between family income and student demand for public institutions.

Several studies have demonstrated that student ability has a considerable effect on the types of institutions demanded by students. Generally speaking, students tend to look for institutions where the profile of current students provides a good match with their own ability

(see Spies, 1973; Venti & Wise, 1982; Fuller, Manski & Wise, 1982; Tierney, 1983; Weiler, 1994; Toutkoushian, 1999). Zemsky and Oedel (1983) found that as academic achievement and/or educational aspirations rise, students are more likely to select a private institution over a public institution. DesJardins et al. (1999) concluded that ACT-taking students who planned on pursuing an advanced degree were more likely than other students to apply to the University of Minnesota.

The present study makes several contributions to the literature on student demand. First, the focus here is on the second stage of student demand; namely, the proportions of seniors in New England who have taken the SAT and have had their test scores submitted to either their in-state PLGU, or to a particular out-of-state PLGUs in the region. By using the set of seniors who have taken the SAT as the designated population, the resulting proportions reflect the initial demand for PLGUs among potential college-bound seniors. Second, this study aggregates data for six states over a twenty-four year period (1976-99) into a single dataset, and applies fixed and random effects models that are tailored to panel datasets to estimate the parameters of interest. This approach is useful for macro-level student demand studies because it greatly expands the degrees of freedom available for estimation. Third, models will be presented for both in-state demand for PLGUs in New England, and out-of-state demand for one PLGU in the region. The contrast between in-state and out-of-state demand is of particular relevance to New England, given the large disparity between in-state and out-of-state tuition rates charged by PLGUs and the heavy reliance on tuition revenue from both types of students.

Research Methods

Data Sources. Most of the data used in this study are taken from the state-level annual reports produced by the College Board for the six New England states (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont) for the years 1976 through 1999. These reports include information on the cohorts of seniors in each state who have taken the SAT at least once during high school. Only data on the most recent examination date are reported for each student. The reports provide aggregate information on the characteristics of all SAT-taking seniors in each state, including their average SAT scores, family income, and educational plans. Tuition and fee information for each PLGU were obtained from their respective offices of institutional research, and average tuition and fees for all private four-year universities in the United States were obtained from the U.S. Department of Education (1999). The Consumer Price Index for all urban areas in the United States (base year = 1983-84) was used to deflate median family income.

Each state's College Board report lists the thirty most frequently-designated institutions to which SAT-taking seniors had their test scores sent. From this information, a measure of the initial demand for an institution is defined as the proportion of these students having their test scores sent to the institution in question. One limitation of this approach is that it can only be applied to institutions that consistently appear in a state's list of thirty most frequent designations. For this reason, this study is restricted to the set of six PLGUs in New England: the University of Connecticut, the University of Maine, the University of Massachusetts, the University of New Hampshire, the University of Rhode Island, and the University of Vermont.

Variables. For each state, two *dependent variables* are constructed. The first dependent

variable *%RDEM* is the proportion of each state's SAT-taking seniors who had their test scores sent to their in-state PLGU:

$$(1) \qquad \%RDEM_{jt} = \left(\frac{d_{ijt}}{n_{jt}}\right) x\ 100, \quad for\ i=j$$

where subscript j = state, subscript t = year, d_{ijt} = number of seniors in state j having their test scores sent to the i-th PLGU in year t, and n_{jt} = number of seniors in state j and year t who have taken the SAT. A second dependent variable is also defined as the proportion of each state's SAT takers having test scores sent out-of-state to the University of New Hampshire (UNH):

$$(2) \qquad \%UNHDEM_{jt} = \left(\frac{d_{ijt}}{n_{jt}}\right) x\ 100, \quad for\ i=UNH,\ j\neq i$$

The University of New Hampshire is chosen as the out-of-state PLGU for analysis because in every year between 1976 and 1999 it appeared in the lists of top thirty designations for each of the other five New England states. This variable therefore represents initial student demand in New England for out-of-state postsecondary education at UNH.

It is posited that initial student demand will be a function of several *independent variables*. The most obvious factors that should influence student demand is the price of attending the institution in question, and the price of attending competing institutions. The six PLGUs in the region compete with private institutions for students, as well as with each other. For the in-state student demand model, the price variable is the ratio of the average tuition and fees charged by all four-year private universities to the in-state tuition and fees for each PLGU.

Alternatively, in the non-resident demand model where the dependent variable is %UNHDEM, two price variables are used: (1) the ratio of private tuition and fees to non-resident tuition and fees at the University of New Hampshire, and (2) the ratio of non-resident tuition and fees for UNH to the in-state tuition and fees for each state. The tuition and fee figures are list prices and do not represent the net prices faced by students after taking into account financial aid. Only gross tuition prices are used here, in part due to data not being available on the level of tuition discounting at the six PLGUs and private institutions for the years 1976 through 1999.[6] One measure of the ability of students to pay for their education is captured by the median family income of SAT-taking students, deflated by the Consumer Price Index to take into account changes over time in the purchasing power of income.

Student demand for public higher education may also vary according to student ability. This is captured by two variables: the average test scores on the math portion of the SAT and the percentage of SAT-taking seniors who finished in the bottom 60% of their high school class.[7] The average math SAT scores for the years 1996 through 1999 have been recentered to the original scale for consistency. Student educational plans may also affect demand for in-state PLGUs. The first of these two variables is the percentage of SAT-taking seniors planning to major in education, which may have a positive impact on the demand for PLGUs given their historic role in providing training for teachers at the K-12 level. A second variable based on educational plans is the percentage of SAT-taking seniors who seek to obtain a doctorate degree. This last variable may also reflect to some degree changes in student ability and/or motivation, and could have a positive or negative effect on demand for PLGUs.

Analyses. The data for the six New England states are pooled into a single panel dataset

with 24 x 6 = 144 observations. Two separate sets of student demand models will be estimated in this study. The first set of models correspond to the demand for in-state PLGUs in each state. The fixed-effects model can be expressed as follows:

$$(3) \qquad \%RDEM_{jt} = \alpha_1 PRIRATIO_{jt} + \alpha_2 INCOME_{jt} + \alpha_3 SATM_{jt} + \alpha_4 \%LOWHS_{jt} + \alpha_5 \%DOCT_{jt} + \alpha_6 \%EDUC_{jt} + \alpha_7 MAINE_j + \alpha_8 MASS_j + \alpha_9 NH_j + \alpha_{10} VERMONT_j + \alpha_{11} CONN_j + \alpha_{12} RI_j + \varepsilon_{jt}, \quad t=1,...,24; j=1,...,6$$

where *PRIRATIO* = ratio of average private tuition and fees to the tuition and fees charged by PLGUs to their in-state students, *INCOME* = median family income of SAT-taking seniors, *SATM* = average scores on the math portion of the SAT, *%LOWHS* = proportion of SAT-taking seniors finishing in the bottom three-fifths of their high school class, *%DOCT* = proportion of SAT-taking seniors planning to obtain a doctorate degree, *%EDUC* = proportion of SAT-taking seniors planning to major in Education, *MAINE, MASS, NH, VERMONT, CONN* and *RI* are dummy variables for the six New England states, α_1 to α_{12} = coefficients to be estimated, and ε_{jt} = random error term.

When ordinary least squares is applied to panel data with separate dummy variables for each group (state), it is referred to as a fixed effects model. The fixed effects approach is appealing in this particular instance because demand models estimated for a single state would have a relatively small number of observations. For example, if the model were estimated separately for the state of New Hampshire, there would only be seventeen degrees of freedom in

the model, whereas a fixed effects model with the same regressors would have 144 - 12 = 132 degrees of freedom. A second approach that could be used with panel data is to estimate a random effects model:

$$(4) \quad \%RDEM_{jt} = \alpha_0 + \alpha_1 PRIRATIO_{jt} + \alpha_2 INCOME_{jt} + \alpha_3 SATM_{jt} + \alpha_4 \%LOWHS_{jt} + \alpha_5 \%DOCT_{jt} + \alpha_6 \%EDUC_{jt} + \varepsilon_{jt} + \mu_j, \quad t=1,...,24; j=1,...,6$$

where all variables are defined as before, except that the six state-specific dummy variables are replaced by a single intercept (α_0), and the error term now consists of a random component (ε_{jt}) and a state-specific component (μ_j). Intuitively, the fixed effects model builds the state effects into the intercepts of the equation and forces the same slopes over time, whereas the random effects model posits both a state and time effect and models this as part of the error term.

Drawing on the literature, there are a number of predictions that can be made regarding the effects of specific variables on initial student demand. According to the standard notion of consumer demand, the private to in-state price ratio should have a positive effect on in-state demand ($\alpha_1 > 0$). This would reflect that as the relative price of attending competing (private) institutions rises, due to a higher than average increase in private tuitions or a lower than average increase in PLGU tuitions, the initial demand for attending PLGUs should rise. With regard to income, an argument could be made that α_2 could be either positive or negative. Students could consider their in-state PLGU to be a "normal good," meaning that their demand for PLGUs will rise as their income rises, then $\alpha_2 > 0$. Alternatively, as income rises, students may increasingly

substitute away from lower-priced public higher education and towards higher priced private or out-of-state public colleges and universities, resulting in a negative income effect (see DesJardins et al., 1999).

The next three variables (*SATM, %LOWHS, %DOCT*) represent various measures of student ability. The effects of these variables on initial demand for in-state PLGUs depend on students' perceptions of the prestige of each PLGU. Previous research on student demand has documented that students tend to select institutions where their ability more closely matches the average ability of students (e.g., Spies, 1973; Toutkoushian, 2000). If the institutions are considered to be highly selective and attractive to higher-ability students, then one might expect to find that initial student demand for their in-state PLGU rises as average student ability rises among SAT takers in the state (i.e., $\alpha_3 > 0$, $\alpha_4 < 0$, and $\alpha_5 > 0$). Finally, the last variable (*%EDUC*) is expected to have a positive impact on the proportion of SAT takers having their test scores sent to their in-state PLGU.

Similar fixed effects and random effects models to those shown in equations (3) and (4) can also be specified for out-of-state initial demand among SAT takers for UNH within New England:

$$
\begin{aligned}
(5) \qquad \%UNHDEM_{jt} &= \beta_1 UNHRATIO_{jt} + \beta_2 PRIUNH_j + \beta_3 INCOME_{jt} \\
&+ \beta_4 SATM_{jt} + \beta_5 \%LOWHS_{jt} + \beta_6 \%DOCT_{jt} \\
&+ \beta_7 \%EDUC_{jt} + \beta_8 MAINE_j + \beta_9 MASS_j \\
&+ \beta_{10} VERMONT_j + \beta_{11} CONN_j + \beta_{12} RI_j + \nu_i, \quad t=1,...,24; \; i = NH; \; j \neq i
\end{aligned}
$$

(6) $$\%UNHDEM_{jt} = \beta_0 + \beta_1 UNHRATIO_{jt} + \beta_2 PRIUNH_j + \beta_3 INCOME_{jt} + \beta_4 SATM_{jt} + \beta_5 \%LOWHS_{jt} + \beta_6 \%DOCT_{jt} + \beta_7 \%EDUC_{jt} + \nu_{jt} + \mu_j, \; t=1,...,24; \; i = NH; \; j \neq i$$

where *UNHRATIO* = ratio of UNH's out-of-state tuition and fees to the tuition and fees charged by other PLGUs to their in-state students, *PRIUNH* = ratio of average private tuition and fees to UNH's out-of-state tuition and fees, β_1 to β_{12} = a set of coefficients to be estimated, ν = a random error term, and all other variables are defined as in equation (3). Therefore, the focus of equations (5) and (6) is on the factors that influence the proportion of each state's SAT-taking seniors who initially consider going out-of-state to attend the University of New Hampshire. A priori, one would expect to find that $\beta_1 < 0$, implying that as the relative cost of attending UNH versus the in-state PLGU rises, the demand for attending UNH among non-resident students should fall. Similarly, increases in the relative cost to a non-New Hampshire resident of attending a private four-year institution versus going out-of-state to UNH should lead to an increase in demand for UNH (i.e., $\beta_2 > 0$). As before, the effects of income and student ability on the demand for UNH among non-residents are ambiguous, depending on how out-of-state students perceive UNH relative to their other postsecondary options. Finally, increases in the proportion of SAT takers in each state planning to major in Education should have a positive impact on their demand for attending UNH since these additional students could major in Education at UNH.

Estimation. Both fixed effects and random effects models are estimated in this study. The fixed effects estimator is a version of ordinary least squares, whereas the random effects

estimator relies on generalized least squares (see Greene 1997, for details). A complication in the application of these procedures is that the panel data are likely to be affected by both heteroscedasticity and autocorrelation. The dependent variables represent the proportions of SAT takers sending their test scores to a given institution, and are actually aggregate forms of a binary choice process. In other words, the underlying data consists of the choices of n_{jt} SAT-taking seniors in each state, where each student's choice can be coded as one if the student sent his/her test scores to a given PLGU and zero otherwise. Rather than observing the decisions of these individual students, however, what is observed is the proportion of ones in the sample. Therefore, the dependent variables *%RDEM* and *%UNHDEM* properly follow a binomial distribution, which introduces heteroscedasticity to the model since the variance of the error terms in equations (3) through (6) equal $p_{jt}(1- p_{jt})/n_{jt}$ (where p_{jt} = proportion of SAT-taking seniors in state j at time t sending test scores to an institution). Weighted least squares is used to correct for heteroscedasticity since the form of heteroscedasticity is known, with the weights w_{jt} set equal to the square root of the inverse of the variance of the error term:[8]

$$(7) \qquad w_{jt} = \sqrt{\frac{n_{jt}}{p_{jt}\,(1-p_{jt})}}$$

See Hoenack (1967; 1971) for a similar approach. A second complication is that the results from time-series are often affected by autocorrelation. Preliminary investigation revealed that this is the case with the present study. Accordingly, the results are also corrected for first-order autocorrelation using the Cochrane-Orcutt method. Finally, the dummy variable for Massachusetts is interacted with the price ratio variable in equations (3) and (4) since it was

found that the student response to the sticker price ratio in this state was dramatically different from the other five New England states.

Results

Descriptive Statistics. Table 2 presents descriptive statistics for the variables used in the various student demand models. The data are pooled across states and years.

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Insert Table 2 Here

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From Table 2, it can be seen that over this time period in New England, on average thirty-eight percent of the seniors who took the SAT had their test scores sent to their own (in-state) PLGU, and this percentage varied between nineteen and fifty-six percent in individual states. Not surprisingly, the percentages of SAT-taking seniors having their test scores sent out-of-state to the University of New Hampshire were much smaller, ranging between two and thirteen percent.

With regard to tuition and fees, Table 2 shows that the New England PLGUs charge considerably higher rates to out-of-state students than they do to in-state students, with the listed tuition and fees at the PLGUs for out-of-state students being over two and one-half times as high as the rates at the same institutions for in-state students. The listed price for attending a private four-year university was about twelve percent higher than the out-of-state rates at PLGUs, and average almost three and one-half times as high as the rates at PLGUs for in-state students. It should be noted that due to higher levels of tuition discounting at private institutions, as well as for non-resident students attending public institutions, the differences in net prices of attendance

are lower. Among SAT-taking seniors, the median family income in the region averaged over $33,000, nearly one-third were in the bottom 60% of their high school class, thirteen percent planned on eventually earning a doctorate degree, and almost one in ten noted that they planned on majoring in Education.

Table 3 offers a glimpse into how selected variables varied by state:

****

Insert Table 3 Here

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Note that the average proportion of SAT-taking seniors in each state having their test scores sent to their in-state PLGU varies from a low of 26% in Massachusetts up to a high of 48% in Rhode Island. Smaller differences were found across New England with regard to the percentage of students having their test scores sent out-of-state to the University of New Hampshire. Differences in the cost of attendance are reflected in the varying ratios of average private to in-state tuition and fees, with in-state tuition rates being lowest in Maine and highest in Vermont. The pattern of median family incomes of SAT-taking seniors is similar to what is found for the states as a whole, with Connecticut having the highest average income and Maine the lowest average income in the region.

While the descriptive statistics in Tables 2 and 3 are interesting, they do not reveal how selected factors have changed over time in the region. Figure 1 shows how the two dependent variables considered here — the percentage of SAT takers sending test scores to either their in-state PLGU or the University of New Hampshire — vary over the time period from 1976 through 1999. The state-specific percentages are averaged for all New England states:

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Insert Figure 1 Here

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In 1976, over forty percent of the SAT-taking seniors in the region had their test scores sent to their in-state PLGU, and over five percent had sent their test scores to the University of New Hampshire. These percentages increased considerably during the next ten years, culminating in shares of 43% and 9% respectively as of 1986. The sharp increase seen for 1986, however, was partially attributable to a change in policy at the College Board. Prior to 1986, test takers could have their test scores sent to a maximum of three institutions at no charge, but in 1986 this number was increased to four institutions. A dummy variable for the years 1986-1999 was added to equations (3) through (6) to test for this shift difference. Since the variable was insignificant in all instances and did not change the findings from the model, the dummy variable was not included in the models presented here. From 1986 to 1999, both percentages have been on a fairly steady downward trend, with an average of only thirty percent of SAT-taking seniors currently having their test scores sent to their in-state PLGU and less than five percent choosing to send their test scores out-of-state to UNH.

Not surprisingly, this downward trend has been a cause for concern among policymakers and analysts in the region. One possible explanation for the decline in interest among New England seniors for their in-state PLGUs is that the relative price of attending private versus public institutions has declined. Figure 2 shows how the ratio of average private tuition and fees to average in-state public tuition and fees for the six New England PLGUs has changed from 1976 to 1999. With the exception of the last three years, changes in this ratio closely match the

changes in demand for in-state PLGUs. Between 1978 and 1987, for example, the ratio of private to public in-state tuition and fees rose from 330% to nearly 400%. Since 1987, however, this ratio has declined steadily, reaching its lowest point of 310% in 1995 before rising slightly during the past three years.[9]

****

Insert Figure 2 Here

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The next chart (Figure 3) shows how the median family incomes of SAT-taking seniors in New England have changed from 1976 to 1999 in New England. The data represent the six-state average of the median family incomes after adjusting for inflation. Note that from 1981 to 1988, real family incomes in the region grew by over $6,000. From the late 1980s through 1993, however, median incomes declined, but have rebounded in recent years to approach their highs of the late 1980s. The pattern is very similar to that found for the private to public tuition and fee ratio, and with the exception of the last several years, the demand for in-state PLGUs (and UNH for out-of-state students) in the region.

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Insert Figure 3 Here

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Figure 4 examines the changes over time in the percentage of SAT-taking seniors in the region who express an interest in pursuing a doctorate degree. This pattern is markedly different from that found for either private-to-public tuition ratios or median family income, in that the percentage varied little between the late 1970s and late 1980s, but during the 1990s has increased

from 11% to over 16%.

****

Insert Figure 4 Here

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Finally, the data also show that there has been a modest increase in the proportion of lower-ability students in the pool of SAT-taking seniors in New England. In 1976, twenty-six percent of the SAT-taking seniors reported being in the bottom three-fifths of their high school class. By 1980, this percentage had risen to 31.8%, with slower growth through the 1990s (33% in 1990 and 33.5% in 1999). These figures could reflect the success of higher education in making college accessible to traditionally disadvantaged students such as first-generation college students and students from families with lower incomes.

Multivariate Results. Table 4 presents the findings from the fixed effects (column 1) and random effects models (column 2) for initial student demand in New England for their in-state PLGUs. The coefficients represent the effect of a one unit change in each variable on the *percentage* of SAT takers in each state having their test scores sent to a particular institution.

****

Insert Table 4 Here

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A quick glance at the results in Table 4 shows that similar findings are obtained from both the fixed effects and random effects models. The variables in the model account for over sixty percent of the variation in initial student demand for their in-state PLGUs. The Likelihood Ratio test statistics show that both the fixed effects and random effects models are a significant

improvement over applying OLS to the panel data without controlling for state effects.

As expected, the demand for in-state PLGUs rises as private institutions become more expensive relative to in-state PLGUs, and vice-versa. The magnitude of this effect, however, appears to be fairly small, in that a one hundred percentage point increase in the private-to-public tuition ratio would increase the proportion of SAT-taking seniors having test scores sent to their in-state PLGU by two percentage points. Median family incomes are also shown to have a positive effect on the demand for public in-state institutions in New England, showing that in the aggregate students in the region do not substitute away from public higher education as their ability to pay for colleges rises and that public higher education is viewed as a normal good. The estimated coefficient for this variable from the fixed effects model, for example, suggests that a $1,000 increase in real incomes would lead to a predicted 0.66 percentage point increase in student demand for in-state PLGUs.

The effects of aggregate student ability on the demand for in-state PLGUs are mixed. Changes in either the average SAT scores of seniors on the mathematics portion of the test, or the proportion of SAT takers from the bottom 60% of their high school class, do not have any impact — positive or negative — on the demand for in-state institutions. At the same time, as the proportion of students planning to pursue a doctorate degree rises, the demand for in-state PLGUs declines. Finally, changes in the proportions of SAT-taking seniors planning to major in Education have no impact on their demand for in-state PLGUs.

Table 5 contains the results for the fixed effects and random effects models when applied to the initial student demand for UNH among non-resident SAT-taking seniors in New England:

********** Insert Table 5 Here **********

While the findings from the fixed effects and random effects models are generally similar, there is a notable exception in that increases in average math scores lead to reductions in demand for UNH in the random-effects model, and have no impact in the fixed effects model. The ratio of private to out-of-state tuition has a positive effect as expected on the out-of-state initial demand for UNH among New England's SAT-taking seniors. The only other significant factor to influence out-of-state demand for UNH is the negative effect of a rise in the proportion of SAT-taking seniors intending to pursue a doctorate degree.

Summary

This study has shown how student demand models can be applied to the SAT-sending behavior of students. By utilizing a panel data approach to the analysis, the sample size can be increased considerably, leading to a reduction in standard errors and allowing for more complete model specifications to be used by analysts. The results for New England show that the changing pattern in the demand for PLGUs from 1976 through the late 1990s has been largely due to changes in the relative price of attending public and competing institutions, and changes in median family income. During the 1990s in particular, as the relative price of attending private institutions declined and median family incomes increased, they led college-bound students to substitute away from public land-grant universities in the region. The continued decline in demand for PLGUs in the last three years is perhaps explained by the rising degree aspirations of college-bound seniors, and their feeling that their needs would be best served at non-PLGUs.

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Table 1: Trends in Total Fall Enrollments by Type of Institution and State, Fall 1975-96

				Percentage Change:		
	Fall 1975	Fall 1990	Fall 1996	1975 - 90	1990 - 96	1975 - 96
Public enrollments						
Connecticut	93,567	109,556	97,588	17.1%	-10.9%	4.3%
Maine	31,092	41,500	37,888	33.5%	-8.7%	21.9%
Massachusetts	173,564	186,035	173,416	7.2%	-6.8%	-0.1%
New Hampshire	24,205	32,163	36,365	32.9%	13.1%	50.2%
Rhode Island	32,311	42,350	37,487	31.1%	-11.5%	16.0%
Vermont	17,145	20,910	20,139	22.0%	-3.7%	17.5%
Total: New England	**371,884**	**432,514**	**402,883**	**16.3%**	**-6.9%**	**8.3%**

				Percentage Change:		
	Fall 1975	Fall 1990	Fall 1996	1975 - 90	1990 - 96	1975 - 96
Private enrollments						
Connecticut	54,924	59,048	57,773	7.5%	-2.2%	5.2%
Maine	9,351	15,686	17,757	67.7%	13.2%	89.9%
Massachusetts	210,921	231,798	236,911	9.9%	2.2%	12.3%
New Hampshire	16,825	27,347	28,098	62.5%	2.7%	67.0%
Rhode Island	32,168	35,923	34,945	11.7%	-2.7%	8.6%
Vermont	11,950	15,488	14,951	29.6%	-3.5%	25.1%
Total: New England	**336,139**	**385,290**	**390,435**	**14.6%**	**1.3%**	**16.2%**
Total: Public + Private	***708,023***	***817,804***	***793,318***	***15.5%***	***-3.0%***	***12.0%***
National Enrollments						
All Public	**8,834,508**	**10,844,717**	**11,090,171**	**22.8%**	**2.3%**	**25.5%**
All Private	**2,350,351**	**2,973,920**	**3,210,084**	**26.5%**	**7.9%**	**36.6%**
Total: Public + Private	***11,184,859***	***13,818,637***	***14,300,255***	***23.5%***	***3.5%***	***27.9%***

Source: U.S. Department of Education. National Center for Education Statistics. *Digest of Education Statistics, 1998*, NCES 1999-036, by Thomas D. Snyder. Production Manager, Charlene M. Hoffman. Program Analyst, Claire M. Geddes. Washington, D.C.

Table 2: Descriptive Statistics

Variable	Mean	Std. Dev.	Min.	Max.
% demand for public in-state land grant university	38%	8%	19%	56%
% demand for UNH (out-of-state) [1]	6%	2%	2%	13%
Public in-state tuition & fees	$2,834	$1,759	$587	$7,788
Public in-state tuition & fees, adj. for inflation [2]	$2,241	$863	$1,039	$4,641
Public out-of-state tuition & fees, adj. for inflation [2]	$5,798	$1,718	$3,363	$8,792
UNH out-of-state tuition & fees	$8,041	$4,035	$2,694	$15,275
UNH out-of-state tuition & fees, adj. for inflation [2]	$6,495	$1,496	$4,768	$9,103
Average private tuition & fees	$9,198	$4,886	$2,881	$18,177
Ratio: Private to public in-state tuition & fees	346%	74%	212%	519%
Ratio: Private to UNH out-of-state tuition & fees [3]	112%	8%	97%	120%
Ratio: UNH out-of-state to public in-state tuition [1]	319%	73%	178%	481%
Median family income	$33,381	$11,856	$13,000	$59,866
Median family income, adj. for inflation	$28,259	$3,591	$21,862	$37,247
Average SAT-Math scores	472	9	452	497
% bottom three-fifths high school class	33%	3%	22%	39%
% planning to pursue doctorate degree	13%	2%	9%	19%
% planning to major in Education	9%	2%	4%	15%

Notes: [1] New Hampshire is not included in the calculations. [2] Quantities are deflated by the Consumer Price Index for all Urban Areas (1983-84 = base year). [3] Only New Hampshire is included in the calculations. % demand for public in-state land grant university equals the proportion of SAT takers in each state sending test scores to their own land-grant public university. % demand for UNH (out-of-state) equals the proportion of SAT takers in each state sending test scores to UNH. All tuition and fee data represent the gross price of attendance and do not take into account financial aid. Average private tuition and fees are for all four-year private universities in the United States (source: U.S. Department of Education, 1999). Figures for the last two years are estimates. Median family income of SAT takers is based on interpolation of grouped data presented in state reports from the College Board. Average test scores on the mathematics portion of the SAT from 1996 through 1999 have been recentered to the original scale used from 1976 to 1995.

Table 3: Means for Selected Variables by State, FY76-99

Variable	Connecticut	Maine	Massachusetts	New Hampshire	Rhode Island	Vermont
% demand for public in-state land grant university	34%	38%	26%	40%	48%	42%
% demand for UNH (out-of-state)	4%	9%	8%	----	6%	6%
Ratio: Private to public in-state tuition & fees	378%	429%	360%	303%	371%	236%
Median family income, adj. for inflation	$33,399	$24,455	$29,005	$29,708	$27,188	$25,799
Average SAT math score	472	467	471	487	463	472
% bottom three-fifths of high school class	36%	31%	36%	31%	34%	28%
% intending to pursue doctorate degree	14%	11%	14%	14%	15%	11%
% intending to major in Education	8%	10%	7%	8%	9%	10%

Table 4: Demand Models for In-State Public Land-Grant Universities in New England, 1976-1999

Variable	Fixed Effects	Random Effects
Ratio: Private to public in-state tuition	0.024*	0.019+
	(2.17)	(1.80)
Median family income ($1000s)	0.662**	0.774**
	(3.16)	(3.60)
Average SAT-Math scores	0.034	-0.088
	(0.97)	(1.28)
% Intending to pursue doctoral degree	-0.802**	-0.647**
	(3.55)	(2.74)
% Intending to major in Education	0.0005	0.002
	(0.01)	(0.01)
% Bottom three fifths of high school class	-0.182	-0.306
	(0.91)	(1.48)
Interaction: Ratio of private to public in-state tuition and Massachusetts	-0.044**	-0.038*
	(2.79)	(2.57)
R-squared	0.64	----
Likelihood Ratio Test	65.17**	72.08**
Sample size	138	138

Notes: Calculated t-ratios shown in parentheses (absolute values). Weighted least squares is used for both equations, where the weights are defined as $w = \sqrt{(n/(p)(1-p))}$, with n = # SAT takers in each state, p = proportion of SAT takers having test scores sent to the institution in question. Coefficients and standard errors are adjusted for first-order autocorrelation. Likelihood Ratio test compares each model to OLS without state controls (4 df for fixed effects model, 3 df for random effects model). + $p < .10$, * $p < .05$, ** $p < .01$ (two-tailed test).

Table 5: Demand Models for the University of New Hampshire Among Non-New Hampshire SAT Takers in New England, 1976-1999

Variable	Fixed Effects	Random Effects
Ratio: Private to out-of-state tuition at UNH	0.043+	0.051*
	(1.90)	(2.27)
Ratio: Out-of-state tuition at UNH to public in-state tuition	0.001	-0.001
	(0.41)	(0.33)
Median family income ($1000s)	0.096	0.124
	(1.21)	(1.57)
Average SAT-Math scores	-0.001	-0.064**
	(0.11)	(2.62)
% Intending to pursue doctoral degree	-0.359**	-0.314**
	(4.49)	(3.86)
% Intending to major in Education	0.028	0.049
	(0.45)	(0.79)
% Bottom three fifths of high school class	0.051	-0.015
	(0.72)	(0.21)
R-squared	0.70	-----
Likelihood Ratio Test [1]	91.69**	318.62**
Sample size	115	115

Notes: Calculated t-ratios shown in parentheses (absolute values). Weighted least squares is used for both equations, where the weights are defined as $w = \sqrt{(n/(p)(1-p))}$, with n = # SAT takers in each state, p = proportion of SAT takers having test scores sent to the institution in question. Coefficients and standard errors are adjusted for first-order autocorrelation. Likelihood Ratio test compares each model to OLS without state controls (4 df for fixed effects model, 3 df for random effects model). + $p < .10$, * $p < .05$, ** $p < .01$ (two-tailed test).

Figure 1: Proportion of SAT-Taking Seniors in New England Sending Their Test Scores to Their In-State Land Grant Public University and the University of New Hampshire, 1976-99

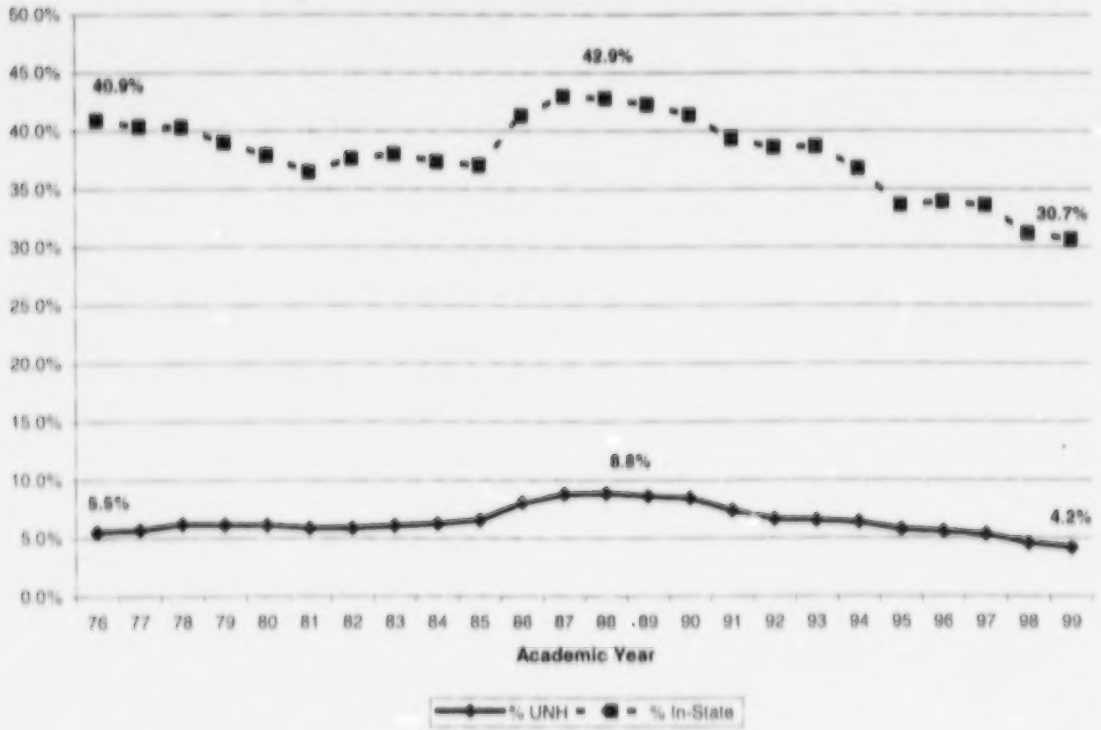


Figure 2: Ratio of Average Private Tuition to Average In-State Tuition at Public Land Grant Universities in New England, 1976-99

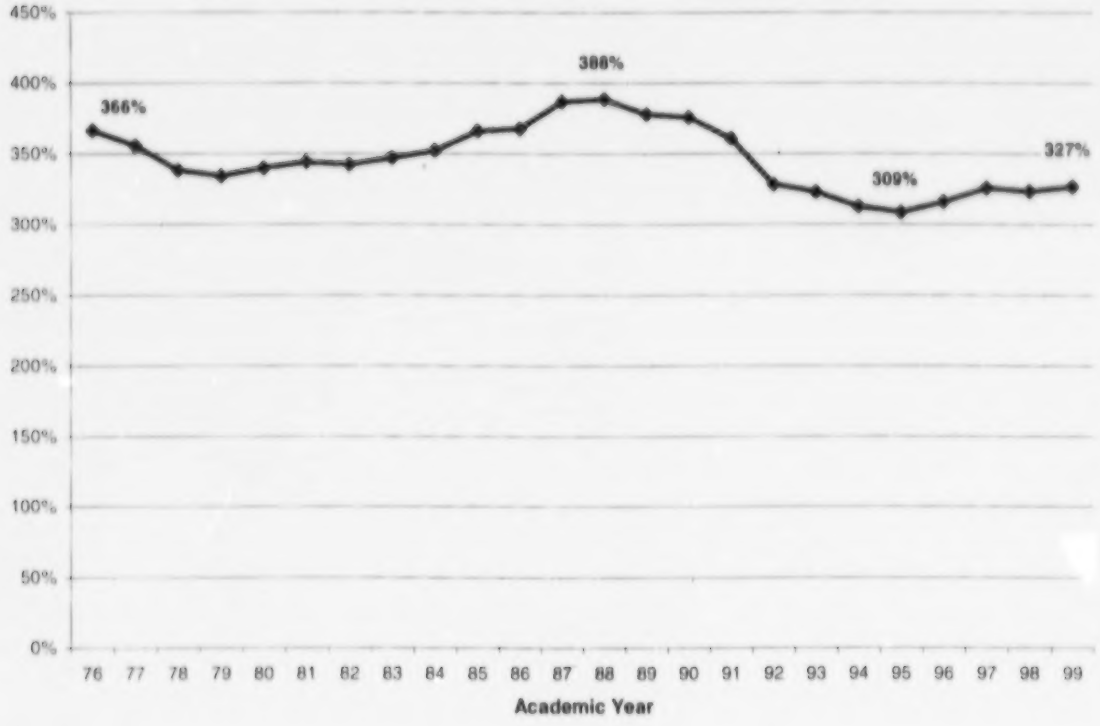


Figure 3: Average Median Family Income of SAT-Taking Seniors in New England, 1976-1999

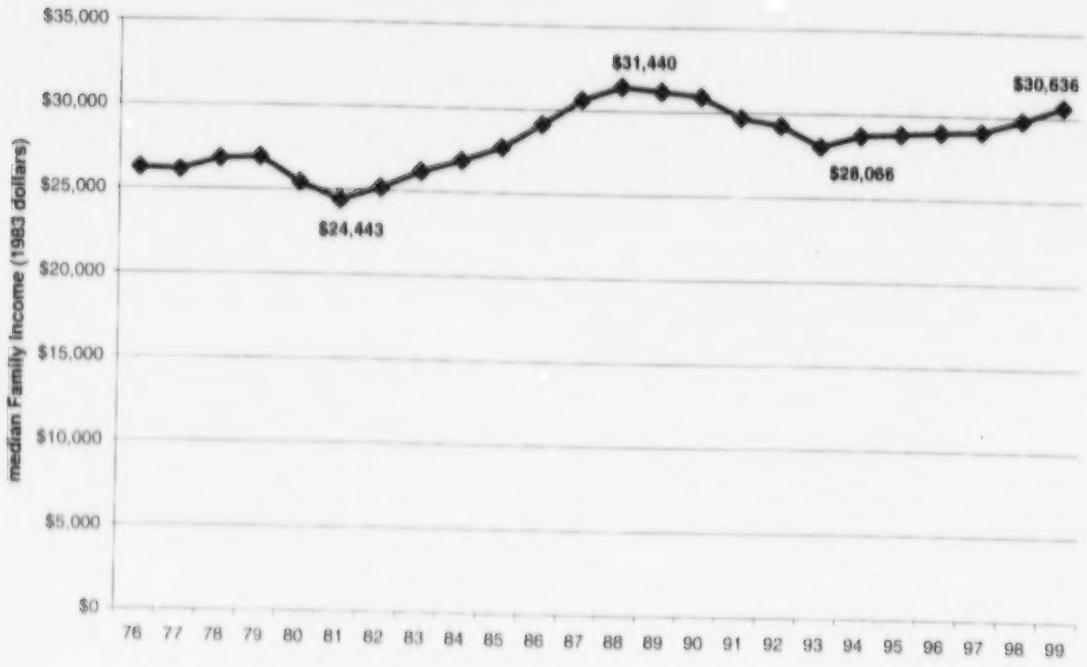
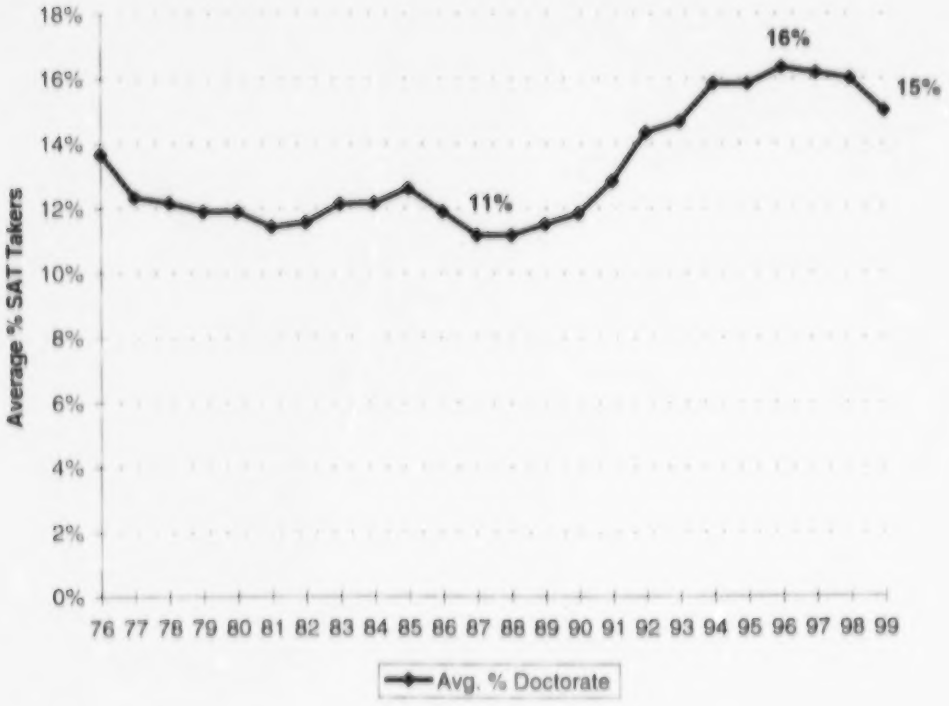


Figure 4: Average Percentage of SAT Takers Planning to Pursue a Doctorate Degree, 1976-1999



ENDNOTES

1. Economists refer to this as the "identification problem," in that it may not possible to determine if the results from the analysis pertain to student demand or institutional supply. In order to identify the student demand equation, at least one factor has to be found that affects the supply of spaces but not student demand, a task that Becker (1990) argues is difficult if not impossible to achieve. The identification problem is more severe when the focus of the study is a particular institution, rather than groups of institutions, since supply constraints have a greater potential to influence enrollment figures for one institution. See Radner and Miller (1975) for a more complete discussion of this issue.

2. See Paulsen (1990) and Weiler (1994) for similar categorization schemes.

3. This holds if it is assumed that limitations placed by institutions on the number of spaces made available will not affect the application decision of students. It is acknowledged, however, that students may be dissuaded from applying to an institution if they know that the institution has placed a cap on their enrollments and/or raised admission standards.

4. There is a large literature describing the effects of prices, income, and other factors on various forms of student demand for higher education. Given that this study focuses on public higher education, the discussion is generally restricted to findings for the public sector. The reader interested in the broader set of findings from the literature is directed to reviews by Paulsen (1990) and Becker (1990).

5. As noted by Becker (1990), Hoenack did not report income elasticities in his study. These were later calculated by Radner and Miller (1975). The findings presented by Dickey, Asher, and Tweddale (1989) should be interpreted with caution since each regression model was based on only twelve observations.

6. A further complication is that separate tuition discounting figures would be needed for resident and non-resident students, since non-resident students typically receive higher levels of tuition discounting than resident students. Given that private institutions generally engage in heavier levels of tuition discounting than do public institutions, the ratio of the net price of attendance will be lower than the ratio of sticker prices used here. If the changes in the ratio of the net prices of attendance are highly correlated with changes in the ratio of the gross prices of attendance used here, then similar inferences will be drawn in the statistical models to follow.

7. Similar results were found when the math score on the SAT was replaced by the verbal score on the SAT.

8. This problem could also have been addressed by using either a logit or probit model to estimate the parameters. These options rely on maximum likelihood estimation and can address the issue of heteroscedasticity. One difficulty in implementation, however, is that when weighting is used with the logit and probit models, it often results in unusually small standard errors and inflated t-statistics. Additionally, there is a problem with applying the logit and probit procedures to panel data, in that the algorithms in programs such as LIMDEP place restrictions on the number of panels (years) that can be used.

9. These ratios most likely overstate the true differential in the relative net cost of attendance, given the higher level of tuition discounting in the private sector than in the public sector. If it were possible to adjust the figures for tuition discounting, however, the same general pattern would most likely emerge since private institutions have increased their reliance on tuition discounting during the 1990s. It should also be noted that it is not clear whether gross or net tuition rates are the proper unit of analysis for this purpose. While many students do not pay the gross tuition rates posted by institutions, at the time of initial inquiry to an institution, an SAT-

taking senior may have little knowledge of the net price of attendance he/she would be charged, and thus may base initial demand decisions more on gross tuition rates.